

GREAT SMOKY MOUNTAINS NATIONAL PARK AS A BIOSPHERE RESERVE: A RESEARCH/MONITORING PERSPECTIVE

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NATIONAL PARK SERVICE
SOUTHEAST REGION

UPLANDS FIELD RESEARCH LABORATORY
GREAT SMOKY MOUNTAINS NATIONAL PARK
TWIN CREEKS AREA
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AS A BIOSPHERE RESERVE:
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Research/Resources Management Report No. 23

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INTRODUCTION

The United Nations Educational, Scientific, and Cultural Organization (UNESCO), in 1968, began to develop a program to solve worldwide management problems arising from the interactions of man and his natural environment. In 1970, plans were approved at the UNESCO General Conference for the Man and the Biosphere Program (MAB), and the governing body (the International Coordinating Council-ICC) was established. In 1972, at the invitation of the Director General of UNESCO, the United States Department of State established a national committee for MAB in the United States National Commission for UNESCO, and the United States began an active role in the MAB Program.

The MAB Program was conceived as an international, intergovernmental, interdisciplinary, problem-solving effort focusing on: the general study of the structure and functioning of the biosphere and its ecological regions; the systematic observation of changes brought about by man in the biosphere; the study of the effects of these changes upon plant and animal life; and the public education and need for scientific information on these subjects.

The Man and the Biosphere Program, as can be seen, encompasses the entirety of relationships humans have with their surroundings.

Therefore, in order to embark on real, concrete tasks, 14 project areas have been defined by the International Coordinating Council. Projects 1 through 7 focus on particular kinds of geographic areas (forests, grazing lands, arid lands, fresh and marine water, islands, mountains, and tundra). Project 8 concerns the development of an international network of "biosphere reserves," protected areas for research, monitoring, and conservation. Projects 9 through 14 focus on what might be termed systems and processes (major engineering work, demographic changes, urban systems, pesticide use, environmental perception, and pollution). Projects are not considered mutually exclusive, and actual research and training activities may include several projects. Special working groups and expert panels set up by the ICC coordinate national contributions and define international core programs to ensure that comparable methodology is used for the various projects.

MAB Project 8, officially entitled, "Conservation of Natural Areas and of the Genetic Material They Contain," seeks to utilize biosphere reserves for the purposes of research, monitoring, and training on the impacts and ecological effects of human activities on world ecosystems. Since 1974, when criteria for the choice and establishment of biosphere reserves were first developed (MAB Report No. 22, 1974), more than 200 areas have been proposed by some 40

countries. To date the United States has 28 areas officially designated as biosphere reserves, representing many of the biogeographical regions of the United States (M.D.F. Udvardy, 1975).

The U.S. National Committee for MAB, as part of MAB Project 8, sponsored an Eastern Biosphere Research Workshop at Gatlinburg, Tennessee in November 1976. That workshop served as the stimulus for this attempt to develop a research perspective for the role of the Great Smoky Mountains National Park as a biosphere area. The park was designated as a central "core biosphere" area within the Southern Appalachian Region biosphere "reserve cluster," which also includes Coweeta Hydrological Laboratory and Oak Ridge National Laboratory (Figure 1).

The Great Smoky Mountains National Park contains an exceptional abundance and diversity of plant and animal life and comprises 516,000 acres (209,000 hectares) containing some virgin deciduous forests and undisturbed watersheds. This sizable area is proposed to serve as the natural resources baseline for the Southern Appalachian Region biosphere cluster.



Figure 1. Southern Appalachian Region Biosphere "Reserve Cluster"

(after ORNL-DWG 6408)

THE PRESENT NATIONAL PARK SERVICE SCIENCE PROGRAM IN THE SMOKIES

Great Smoky Mountains National Park has a long research history involving many independent studies, primarily by university researchers. Coordination of independently developed projects over the years has not been possible; thus, some locations and taxa within the park are relatively well understood, while others have barely been investigated.

To improve the park science program, the National Park Service established the Uplands Field Research Laboratory in 1975. Three research scientists are employed at the laboratory--a plant ecologist, a wildlife biologist, and an aquatic ecologist. Several seasonal and temporary student employees and technicians support laboratory operations and field studies. The staff is augmented by other staff specialists and contract researchers to a limited degree. The laboratory is located at the Twin Creeks area in Great Smoky Mountains National Park, Gatlinburg, Tennessee. Two lab trailers are also located at Tremont Environmental Center. They contain minimal furnishings for seasonal and temporary use.

Research at Uplands is oriented towards specific park management needs. Current high priority, ongoing projects include:

1. Status of the European Wild Boar
 - a. Estimation of the hog population and determination of hog movements and habits
 - b. Evaluation of hog disturbance to native species
 - c. Determination of control methods for limiting the expansion of the wild boar population
2. Preservation of the native brook trout population
3. Survey and status of aquatic resources systems
4. Evaluation of damage to native fir populations by the exotic wooly aphid
5. Evaluation of human impacts in the park
 - a. Assessment of campsite damage and trail erosion
 - b. Environmental analyses of existing developments and proposed developments within the park

- c. Determination of human interactions with the native fauna
6. Inventory of rare, endangered, and endemic species populations and definition and description of special protection areas
7. Establishment of an information base suitable for fire management decisions
8. Park-wide vegetation survey
9. Status of the black bear
10. Development of remote monitoring techniques

The Uplands Field Research Laboratory staff presents current research results through several media. Management studies are quickly disseminated in the Management Report Series published by the Natural Science and Research Division, Southeast Regional Office of the National Park Service. Researchers also present their findings in various research journals. Annually, research and park staff meet in early summer with university personnel and scientists from other government agencies for workshop discussions and presentations of results from individual research projects.

EXISTING FACILITIES

The present research facilities in the park are limited in space and equipment. Additional work space is critically needed for support of MAB-8 studies. Park reference collections are taking up as much room as can be allowed. Some plant and insect collections remain in the park; others have been loaned to various universities. At present, no formal storage for raw data matrices, computer decks or tapes, and master maps exists. Space limitations are likely to become critical within the next 2 years and will affect the development of the Biosphere Reserve Program, particularly projects involving independent researchers who require the use of collections or working space in the park.

THE GREAT SMOKY MOUNTAINS NATIONAL PARK AS A BIOSPHERE RESERVE

In order to provide meaning to biosphere reserve status, the Uplands Field Research Laboratory staff has compared the goals of the "Man and the Biosphere Program" with the goals of National Park Service management. Common goals are: (1) research by the National Park Service in the Great Smoky Mountains National Park is resources-oriented; (2) the park interpretative (educational) program interrelates both the natural and cultural aspects of the park environment; (3) a current research project focuses on broad-spectrum

environmental monitoring under "natural" conditions; and (4) research exploring the impacts of anthropogenic factors on natural ecosystems is now underway.

Despite their commonality, major goals of the MAB-8 Program are only incidentally addressed by the current park research and management programs. For example, studies have investigated the impacts of human interference, such as the effects of logging, exotic species, road construction, and levels of atmospheric pollutants; however, National Park Service research in these areas is often oriented toward immediate management problems within a limited time frame (less than 5 years). Both physical and biological monitoring, because of limited resources, have been highly selective and narrow in scope. Monitoring resources have not been available to study park ecosystems where problems are not immediately apparent. Substantive knowledge of "healthy" ecosystems is important to the MAB-8 Program and will benefit effective long-term management of park resources.

As a part of MAB-8, the National Park Service research program has acquired a broader outlook, including greater planning emphasis on long-term projects and permanent sampling regimes. It is especially important to reiterate that the park is the core area in the Southern Appalachian Reserve Cluster. This role is eminently compatible with

the National Park Service management philosophy requiring minimal disturbance and minimal manipulation of the natural resources.

Data collection programs in the park are being considered for comparison with other areas within and beyond the core unit. Data is needed concerning patterns of ecosystem change common to all deciduous forests. Such data is also important to the establishment of air and water quality standards for the park.

Data for general dissemination needs to be presented in verifiable, well documented, accurate, and usable format. Some MAB-8 data collection by National Park Service scientists may involve base line items not immediately usable by park management, as well as some data which will not immediately appear in an analyzed form. All data will be organized so as to facilitate storage and retrieval. This will bring a more sophisticated research program in the park and should increase data sharing and communication with other agencies and institutions.

Several actions are being taken to integrate the Great Smoky Mountains program with the other areas in the reserve cluster and with the local universities:

1. Efforts begun at early stages are continuing to develop a stable, well-organized program. Since the first visible problems are on the local level, a series of meetings are planned to provide for cooperative program development between personnel of Great Smoky Mountains National Park, Oak Ridge National Laboratory, Coweeta Hydrological Laboratory, and local universities. Detailed discussion of common data bases and cooperative studies are envisioned for future meetings.
2. Coordination with other biosphere reserves will be established. Specifically, laboratory staff will investigate work under way at Hubbard Brook Experimental Forest in New Hampshire to postulate the best possible monitoring programs for the park. A short report on potential common monitoring problems will result.
3. Recurring workshops, in conjunction with the Great Smoky Mountains scientific meetings, are being considered to begin in June 1978. Joint communication efforts for the cluster meetings could be rotated from site to site and organizational responsibilities likewise rotated as one way to keep all parties equally involved in the program. As universities become more fully involved in the program, meetings and coordination responsibilities can be divided among all interested institutions.

4. Cooperative publication efforts for biosphere reports have been discussed, including a common biosphere publication. A rationale is being developed by the National Park Service and Oak Ridge National Laboratory in cooperation with the National MAB-8 Committee.
5. An expanded biosphere program requires multiple-level coordination to keep all agencies and interested scientists informed. Should the program expand, a National Park Service Biosphere Reserve Coordinator is suggested.

DATA BASE REQUIREMENTS

An organized data base is necessary to provide dependable information to researchers working on independent projects and to managers responsible for protecting the biosphere area. In Great Smoky Mountains National Park, part of the data base will be organized and maintained by National Park Service personnel. Some monitoring activities will require long-term attention by personnel from Coweeta Hydrological Laboratory, Oak Ridge National Laboratory or local universities.

Basic information requirements identified during the first regional MAB-8 workshop held at Gatlinburg, Tennessee, November 3-5, 1976, are: (1) topographic maps; (2) airphotos (over regular intervals) and other up-to-date imagery; (3) geologic surveys and maps; (4) soil surveys and maps; (5) hydrological surveys, including water supply and stream flow data; (6) continuous park climatic data; (7) inventories of aquatic and terrestrial plant and animal species and the development of appropriate reference collections; (8) descriptions of select watersheds in the park, in terms of both physical characteristics and biota; (9) vegetation surveys and maps; and (10) a detailed history of human activities in the area, including past and present human impacts on park ecosystems.

A discussion of the status of each identified basic information requirement follows:

1. Topographic maps - A complete set of 7 1/2-minute quadrangle maps (scale 1:24,000) is available for the park. The scale, with 40-foot contour intervals, is adequate for most research uses. Presently 1:24,000 has been adopted as the uniform scale for storage of most map data.
2. Airphotos and other imagery - A complete series of black and white photographs was taken of the park 10 years ago.

Photography from the 1930's is available for restricted use in the park archives. Recently, arrangements were completed to have the entire park reflowed in natural color and color infra-red. Additional high-elevation infra-red photography has been flown for some sections of the park, and spot imagery is available. Multiple sets of good quality satellite imagery can also be obtained.

Imagery for the park is not centrally archived, but a photograph library containing duplicate copies of all available material is planned for the Uplands Laboratory. All new imagery will have one copy placed in the park archives and working copies will be made available.

Present research plans for the park require new low-elevation imagery for both soil and vegetation survey work. Watershed descriptions would be greatly enhanced by the improved imagery. Some of the planning maps in the park should be put on a photograph base as funding becomes available.

3. Geologic survey - A geologic survey has been completed for most of the park. However, geologic data for the southwest park area is not presently adequate for most purposes, and some areas in the park may require detailed quadrangle mapping or specialized maps to support some project activities.

4. Soil survey - The only available soil survey data comes from old county soil survey projects. These out-dated surveys are very generalized and inadequate for present-day use.

Mapping the soils for the entire park will be a time-consuming and expensive project, but soil classification is necessary and should be obtained as soon as possible. The best strategy appears to be to identify major taxonomic groups and relate them to forest type, climate, topography and geology, within the scope of general data requirements. A general soils map for the park could then be prepared. If and when necessary, some watersheds could be mapped in detail.

If a new soil classification map were available for the park, soils could be better identified in the field by scientists working on related vegetation and nutrient cycling projects. Assessments of park disturbances, such as those caused by the European wild boar, could be improved. When environmental impact work is necessary, soil classification data would expedite preparation of environmental documents. General soils work supports other projects and activities and should follow the acquisition of appropriate aerial photographs as an incorporated part of other survey projects.

5. Hydrological data - Analysis of the hydrologic regime existing in Great Smoky Mountains National Park is required to identify physical parameters and correlate them to climatic variables in order to interpret and analyze observed changes. Presently only large-scale survey data are available describing the hydrologic parameters within the park. An intensive study of select drainages is required in conjunction with other ecosystem studies.

Hydrologic parameters are viewed as an important part of the interdisciplinary study effort within the overall program of park and biosphere studies. New measuring techniques need to be developed and relevant parameters determined in order to maintain a continuing program of producing beneficial data for understanding the ecosystems of the Great Smoky Mountains. Knowledge about the physical characteristics of stream systems is a basis to ecological or biological studies in the aquatic and terrestrial fields, and these studies should proceed simultaneously with the earliest data collection efforts.

6. Climatic data - Weather stations maintained in the park by the Tennessee Valley Authority are checked on a daily basis by park staff. Two major stations are located on the Tennessee side of

the park next to Rt. 441, the main road through the park. The stations are widely separated in elevation and represent extremes in climatic conditions. An expansion of climatic data is required to assess hydrologic regimen and microclimatic patterns and augment published materials on the relationship of climate to elevation in the park.

Very little data have been collected in the remote areas of the park. Efforts need to be made to establish remote stations requiring minimal maintenance. National Park Service research staff are working on this problem and are experimenting with remote stations which relay data via satellite. This work is scheduled to continue through 1980. Weather stations could well be added, as funds become available, in representative areas of the park so that variance in climate can be more readily analyzed.

7. Inventory of aquatic and terrestrial plant and animal species -

Check lists of vascular plant species and park voucher collections exist. Specimens are stored at the park and at the University of Tennessee. Extensive collections of bryophytes, lichens and fungi have been made in the park, although there are no published check lists. Vertebrate species lists are also available..

The greatest deficiencies are in collections of invertebrates and aquatic flora and fauna. Check lists are not available, and many groups have not been investigated. An initial study of natural diatom communities is now under way in the park. A general, qualitative survey of the aquatic invertebrates has recently been implemented.

It is suggested that complete collections and species lists be maintained locally. If park facilities are not adequate to store these collections and maintain them properly, arrangements could be made with a local university to curate the park collections.

The highest priority is being given to completing an aquatic species list. Additional species lists will be compiled as specialists and resources are found to do the work. The lists will be published as part of the National Park Service, Southeast Region, Management Report Series, if other more appropriate means are not available.

8. Descriptions of watersheds - Most existing aquatic work in the park has not been organized in terms of communities or ecosystems. Adequate descriptive material does not exist for

many management purposes. Stream fauna (with the exception of some fishes) are not well known and there is presently no data available for assessing the type and the magnitude of changes due to observed disturbances. Relatively little is known about the changes in park aquatic ecosystems resulting from present levels of human activity. Impacts of acid drainage have been studied in some detail, and some work has been done to determine the influence of siltation and other types of changes in water quality. These studies have been limited and preliminary in nature.

Trout populations in the park are being sampled on about a 7-year interval. Programs for the collection of other data on a regular basis have not yet been implemented. Park watersheds need to be classified according to their major chemical and physical characteristics as well as their flora and fauna. Unique areas which may need special protection need to be located and, if possible, a descriptive document should be prepared at an early date.

One or more watersheds will be selected for special study and permanent monitoring stations will be established. This project requires long-range personnel commitments and close coordination

with local research institutes, Coweeta Hydrologic Laboratory, and other Federal Agencies. Segments of this program are under way, but it will take several years before completion and special funding will be required.

9. Vegetation or habitat-type map - The existing parkwide vegetation map was compiled during the 1930's. It is not adequate for present management needs or for general reference use. A number of descriptive papers have been written about the vegetation of the park, but most are limited to specific areas, such as the spruce-fir zone around Mt. LeConte. A classification scheme based on these earlier works could be organized for the high elevations and the virgin sections of the park. Most of the woody successional communities have not been studied in detail, and for some sections of the park, such as the drier forest types on the North Carolina side, species lists and descriptions must be developed.

A comprehensive long-term vegetation survey of the park began in the summer of 1977 and includes the establishment of permanent plots for monitoring changes in the vegetation. Some of the early sites for vegetative mapping and habitat classification have been permanently marked and sampled so that sampling can be

repeated at a later date. Phenology is also being considered and many areas will need to be sampled more than once during the year.

The vegetation survey project involves a trial use of remote sensing as an aid to groundwork. Attempts have already been made by the National Park Service and Oak Ridge National Laboratory to define vegetation zones in select areas of the park.

Vegetation typing is sorely needed by wildlife ecologists and aquatic ecologists working in the park. The project needs to include a very extensive sampling program. This work is time-consuming and will continue for several years.

10. Human history - Although a tremendous amount of data exists on previous human disturbance of park ecosystems, much of it, such as logging records, has never been completely analyzed. No attempt has been made to coordinate this information into one single set of maps. At least two maps delimit "virgin" forest areas in the park, but the maps do not agree and both may well be incorrect.

A detailed historic human impact study and fire history should be conducted simultaneously with the vegetation survey. Time spent in collecting information on the past history of park ecosystems is a good investment in terms of future management needs.

The following factors are to be included and quantified in an inventory of historic human impacts:

- a. Logging: 1) type and completeness of cut, and boundaries; 2) species removed, if selective; 3) other associated disturbances, such as splash dams, railroad grades, and skidding; 4) locations of logging camps and sawmills.
- b. Fire: 1) areas burned on a regular basis for berry crops, weed control, etc.,; 2) large anthropogenic fires, and fires associated with logging; 3) "natural" fires--their distance, extent, and influence; 4) areas completely opened by fires vs. areas burned largely by surface fires.
- c. Grazing and farming: 1) open pastures; 2) grazing territories including wooded areas; 3) locations of herder's cabins, trails and gant lots; 4) old homesites and completely cleared land.

- d. Local human inputs and disturbances: 1) application of herbicides and insecticides; 2) known chemical disturbances of streams, such as the use of Rotenone in early fish management; 3) sites of salt application; 4) sites of gravel dumping or filling activities; 5) cutting of trees for insect or disease control; 6) wildlife management actions.

- e. Position of National Park Service developments, etc.:
1) all buildings and cleared areas, old and new; 2) are roads, old and new; 3) all known campsites; 4) all dumps and waste disposal areas; 5) areas used for "high impact" research work, i.e., intensive trapping.

MONITORING

Several projects are presently incorporated as part of the overall biosphere remote monitoring program. The establishment of this monitoring program will require a continued effort and level of funding beyond that provided by the present National Park Service science program. Expanded monitoring programs are discussed separately, but are not independent of other research needs. Many of the monitoring efforts will be preparatory towards future research projects.

Ongoing monitoring activities now to some minimal degree include: 1) pollutant input and cycling data, including precipitation analysis; 2) weather data (frequency to be determined); 3) basic physical, chemical and biological data for one or two "natural" or pristine watersheds; 4) permanent plot system for monitoring changes in major plant communities; 5) population monitoring of select animal species; 6) population census of all endangered species; 7) population census of exotic species known to have an adverse impact on the native biota; 8) plant phenology stations; and 9) animal mast surveys.

Of the data elements listed, only a few are available in reliable form for the park. The first requirement is to establish a program for accumulation of long-term data and develop a format to make it readily available. Monitoring program status is discussed below:

1. Pollutant monitoring data has been collected in the park over short time periods by the National Park Service and outside investigators. A long-term sampling design is being tested as a part of the biosphere program; it will require regular continuous collection of pollutant data in cooperation with other Federal agencies.

Laboratory facilities for analyses is a constant support requirement. Due to space and equipment limitations, it is unlikely that the park or the Uplands Field Research Laboratory can develop the capability to do locally complex laboratory work.

Remote pollutant monitoring stations will be needed in coordination with other programs. Sampling parameters have to be selectively chosen and should include common variables with other biosphere reserves, in addition to specific variables appropriate to the local area.

2. Weather data is currently collected daily at two stations in the park and should be expanded to include more areas with greater frequency. For a limited number of variables, such as minimum and maximum temperature or total daily precipitation, field staff can regularly record the information as a part of assigned duties. The feasibility of operating continuous weather data stations is being studied and staff will be assigned to maintain the remote stations and collect supplementary information.
3. Basic physical, chemical and biological data for one or two "natural" and/or "pristine" watersheds is a high priority for

project development. Selection of watersheds suitable for study on a long-term basis will require interagency coordination not yet extant.

Monitoring watersheds in remote areas requires establishment of low maintenance stations with data transmission capability. Present watershed monitoring techniques use weirs and other alterations placed along the creeks and streams; alternate techniques to mitigate such disruptions need to be investigated. Additional technician capability will be required to support this effort. The initial financial outlay to organize such a project will be fairly substantial in relation to present budgets. Watershed monitoring will not be expanded to include this project until funding and/or staffing can be developed.

A pilot project evaluating the applicability of remotely sensed data for real time delineation and analysis of water quality changes began in 1976.

4. Although quite a number of vegetation projects have been completed, a parkwide permanent plot system has never been established. In the summers of 1976 and 1977, Dr. Rudolph Becking relocated some of the spruce-fir plots surveyed by

himself and R. H. Whittaker during the early 1960's. The plots were resurveyed and marked with steel corner stakes. Many of these sites are already threatened with rapid change either by the wooly aphid or human disturbance, and some have been altered by windfall. Should hypothesized climatic changes due to increasing CO₂ and other atmospheric pollutants take place, these plots will serve the park as the largest record of change in forest species composition.

Other permanent vegetation plots are being established and employed to evaluate the impact of wild boars in different forest types. Used in conjunction with a series of hog enclosures in disturbed areas, they can be used to evaluate vegetation recovery.

Plots near trails, campsites and other areas intensively used by visitors are being studied to quantify direct human impacts such as trampling and firewood gathering. This plot system can also play a role in fire management and evaluation of insect and disease damage.

The staff of Uplands Laboratory is working in some hog-disturbed and successional areas and emphasis has been placed in working areas of immediate management concern. Work will eventually

expand to include special biosphere study areas encompassing all forest types in the park. Data will continue to be recorded on master maps and made available to other researchers as soon as it is tabulated and verified.

6. Population censuses are under way or planned for exotic species known to have adverse impacts on native biota. Woody exotic plants were surveyed on the Tennessee side of the park in 1975.

A project on endangered vascular plants is also under way and should be integrated into the permanent plot program. Projects assessing species status are being conducted or planned on the major endangered animals, including the mountain lion and red cockaded woodpecker. This is a priority of National Park Service research at the moment. Eventually, the data will be integrated into a biosphere reserve data base and mapping system.

7. Plant phenology stations are required to obtain base data for multiple wildlife studies. Park Naturalist Arthur Stupka kept extensive notes from 1935 to 1964 on blooming times of different species of plants. After his retirement in 1964, this type of data collection ceased. Several wildlife studies now require a

continuation of phenological data collection for monitoring changes in plant communities. Collection of data on blooming, leafing and fruiting times requires regular time commitments and predetermined sampling routes or plots.

Studies on wild boar movements require the continued collection of phenological data. Present preliminary studies may not result in a permanent sampling schedule, but should provide information on location and number of sampling stations and frequency of sampling.

8. Annual mast surveys are required to support ongoing mammal studies. Much of the scientific work with large mammals in the park requires information on the relative productivities of the different forest types. Fruit productivity not only varies from plant species to plant species, but from year to year. The availability of food items, such as acorns, strongly influences movements of black bear, wild boar, and wild turkey, and may also partially determine their reproductive success over a given time period.

It is proposed that the park adopt techniques used in the adjoining Nantahala and Pisgah National Forests in conducting an

annual mast survey. This effort would greatly facilitate accurate vegetation plot data and habitat maps for the park. Some mast traps were set out as part of an independent research project in the fall of 1976, and will likely be expanded in the next 2 years. Acorn production was sampled in a limited area at four sites along lower Anthony Creek during the fall of 1977.

DATA STORAGE AND ACCESS

Information previously collected and provided in a timely fashion will assist investigators and avoid duplication of efforts.

Information gathered by all projects must be catalogued, dated, and filed. Exact data relative to all sampling sites will be critical in quantifying temporal changes in reserve ecosystems.

Specific data handling requirements fall into four categories: 1) library facilities, 2) data storage and cataloging, 3) a computer data base, and 4) interagency cooperation, and are discussed below.

1. The park library contains much of the published material on the Great Smoky Mountains and surrounding area. Collections in the library could be strengthened by the addition of pertinent scientific reprints from journal articles. One problem stems

from independent researchers who have been negligent in sending copies of their finished reports to the library, and this needs to be corrected as soon as possible. The maintenance and expansion of library collections will be important to the Biosphere Reserve Program.

2. The park archives house much of the research material, including original data matrices, master maps, photographs, and other project materials. Storage capability is adequate at the present time, but will be limited for future use when programs expand. One feasible solution in overcoming the lack of duplicate storage space is a microfilm library. A system insuring the safety of archived materials needs to be established where copies of data matrices and other original materials are required for use by park staff and visiting researchers.
3. The early establishment of a computer data base and mapping system is highly desirable. This is a unique project in its own right and will require special cooperation between independent biosphere research scientists and National Park Service personnel. Computer-coded species lists and mapping systems for the park need to be developed. The computer-coded data base should: a) be available to anyone who needs it; b) be compatible

with a majority of university computers; c) be verified as to accuracy and documentation; d) be geographically registered; and e) be of a design that requires simple maintenance with low overhead costs.

4. Interagency cooperation for data handling and sharing ventures is an absolute requirement. Current avenues of cooperation provide a rationale for cost-sharing benefits by utilizing existing systems and abilities. Presently, three activities related to this category are a) the United States Geological Survey Program to identify and catalogue available imagery for biosphere reserves; b) the consideration of a "linked" data base for the biosphere cluster, combining park data with recent data management projects available from Oak Ridge National Laboratory; and c) the National Park Service supported information synthesis project of the University of Oklahoma.

MAB-RELATED RESEARCH PRIORITIES

Two projects that have high National Park Service priority are the vegetation survey and the description of select watersheds.

The vegetation survey began during the summer of 1977 and includes a permanent plot system. Acquisition of natural color and color infra-

red photographs of the park at a scale of 1:24,000 will greatly benefit the vegetative studies.

Organization of a park-wide program of watershed studies began in June 1977 and several projects are under way, but a park-wide program of baseline acquisition has not yet been developed and the project will be limited by restrictions in equipment, budgeting, and manpower.

Preparation of additional species lists will continue through student-supported projects until the major groups have been covered. Park reference collections will be resurrected or reestablished as time and funding permit. Storage space limitations within the park will likely restrict this endeavor and cooperative efforts with university museums will be necessary.

The human history of the park is important; data collection for this project will be correlated with the vegetation survey. It could be organized as a special sub-project of the vegetation survey and will require several sets of maps.

Censuses of the major animals, including rare, endangered, and exotic species, also have a high priority and play an active role in park

research at the moment. "Biosphere reserve" projects may cover some non-problem animal species that are not high management priorities.

Monitoring programs are presently hampered by limitations in staff availability. However, selected monitoring efforts have been initiated and are being evaluated. These activities will be coordinated with the vegetation survey and watershed description project. A combined National Park Service/Environmental Protection Agency venture is under way to develop a system for pollutant monitoring. This project is being synchronized with the park's aquatic program and remote monitoring work. It encompasses system design and implementation of a test case for long-term monitoring in the remote natural areas of biosphere reserves.

As the various programs develop, the availability, storage and protection of data will gain great importance. Special staff support in this area will be necessary, especially since computer processing is involved. The fact that an adequate data handling system is a prerequisite to continuing research work cannot be overemphasized. Many information sources need to be identified and organized, and funding for this endeavor might be accomplished as a specific part of the MAB-8 Program.

CONCLUSION

The Great Smoky Mountains National Park will reap many benefits through its participation and status as a biosphere reserve. One possible advantage could accrue from the increased emphasis placed on developing a well-organized information system in connection with coordinated ecosystems studies. At the moment, vital data is scattered, existing in many forms in undocumented park files and university libraries. Information critically needed today frequently does not exist or cannot be found. Consequently, decisions are often based on inadequate data or, in some cases, delayed due to a lack of adequate information. Resources data, when identified, catalogued, and stored in a tightly-organized data base, will benefit the park by its availability when needed.

AN IDEALIZED TIME SCHEDULE FOR MAB-8 PROGRAMMING
IN THE GREAT SMOKY MOUNTAINS NATIONAL PARK

1977 - Organize first programs

1. Begin vegetation survey, permanent plots, phenology plots, and mast survey.
2. Organize aquatic program for the park.
3. Initiate experiments in remote monitoring.
4. Develop a strategy and proposal for a pollution monitoring system in the Great Smoky Mountains National Park/Coweeta Biosphere Reserve.

1978 - Field program under way

1. Complete new airphotography.
2. Continue vegetation work.

3. Aquatic program continues; design watershed monitoring program and begin small-scale watershed monitoring.
4. Set up preparatory pollution monitoring program; provide for establishment of preliminary monitoring stations.
5. Contemplate needs for weather data collection and coordinate with remote monitoring project.
6. Review status of soil survey data.
7. Begin human history project; coordinate its mapping with the vegetation survey.

1979 - Begin work on information system

1. Vegetation work integrates into continued field information system.
2. Aquatic work begins to return data to management.
3. Hydrologic and geologic (southwest park) soil survey programmed or under way.

4. Human history project begins to contribute data to park management and information system.
5. Organize information exchange with other reserves.

1980 - Begin integration of scientific field data and information system

1. Field work in vegetation survey and watershed description near completion; detailed studies continue.
2. Soils, hydrology, and geology complete or under way.
3. Historical survey near completion.
4. Weather and pollution monitoring stations running on a regular basis.
5. Methods for monitoring remote natural systems developed to a functional level. Methods development and testing to continue.
6. Information system available and usable for some projects.
7. New projects hypothesis-oriented or based on management needs; basic resources data available for most planning needs.

